THE COMPOSITION OF TROPICAL LOWLAND PEAT SAMPLED AT KLANG, SELANGOR, MALAYSIA

B. R. Hewitt
Department of Chemistry, University of Malaya

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Synopsis

The results of analyses of a tropical lowland peat from Klang, Selangor are given and the utilization of the peat is discussed.

Introduction

The distribution, location and mode of formation of tropical lowland peat on the Malayan Peninsula have been the subjects of a previous paper (Hewitt, 1967). The extensive occurrence of peat in tropical lowlands gives to this peat an importance because it is situated in areas suitable for padi cultivation although the peat itself is an extremely poor medium for crop plant growth. The continually waterlogged conditions and the fact that peat does not provide adequate mechanical support means that many crops and particularly tree crops such as rubber cannot be grown successfully on peat.

The chemical environment is also very unfavourable. For example, the low pH of the peat is probably responsible for the release of toxic amounts of some elements. There is in any case usually a low content of most essential nutrient elements and naturally a high carbon to nitrogen ratio. Furthermore, the anaerobic waterlogged conditions result in the formation of toxic substances such as di-hydrogen sulphide and of a very acidic ground water.

In this paper results of chemical analyses of peat are given together with a discussion of these results and of the utilization of peat.

Methods and Results

The peat was sampled from an extensive swamp near Klang, Selangor, part of which carries extensive areas of the original peat swamp forest while other parts have been cleared, drained, burnt and put down to rubber and oil palm. Clearing, burning and draining has resulted in shrinkage of the peat so that the level has dropped by about 3 feet.

Sampling was carried out on both virgin and on cleared peat with a peat auger at 5 sampling points along a two-mile traverse. The depths of sampling 0–1 ft, 1 ft–2 ft and 2 ft–4 ft. Initially the analyses were done on individual samples but the results for each depth level were similar so that samples were bulked for the virgin and cleared peat to give three main samples, namely 0–1 ft, 1 ft–2 ft, 2 ft–4 ft. Since the top layers of the cleared peat had been burnt and drainage had resulted in further shrinkage the 2 ft–4 ft sample contained the underlying blue-grey clay.

The profile descriptions of the samples are :

Virgin Peat

Coloured black, with leaves and other vegetable material distinguishable in the top layers together with some twigs, pieces of wood which graded into a more amorphous peat of reddish colour with depth. The lower portions still contained undecomposed pieces of wood.

Cleared Peat

This contained a thin layer of charcoal on the top and some of the underlying clay in the lower portions. Between these there was an amorphous peat of reddish brown colour.

The samples were transferred to the laboratory in polythene bags then air dried and passed through a 2·0 mm. sieve for analysis. In later work it was necessary to use finer size of sample and <0·5 mm. sized samples were obtained after the appropriate quartering of the <2·0 mm. samples. On drying all peat samples had a reddish brown colour except for the 2 ft–4 ft sample from the cleared peat which was grey in colour.

Analysis was carried out on individual samples as shown below in Table 1.

Table 1

pH, Loss on ignition (%) and ash (%) of Klang peat

Individual Virgin peat samples				
Depth	Sample	pH	Loss on Ignition (%)	Ash (%)
0–1 ft	1	2·4	95·3	4·7
	2	2·5	95·8	4·2
	3	2·3	96·6	3·4
	4	2·3	92·3	7·7
	5	2·1	92·5	7·7
1 ft–2 ft	1	2·4	87·7	12·3
	2	2·5	98·2	1·8
	3	2·3	97·5	2·5
	4	2·3	96·2	3·8
	5	2·2	98·6	1·4
2 ft–4 ft	1	2·4	97·7	2·3
	2	2·4	97·5	2·5
	3	2·3	96·4	3·6
	4	2·3	97·7	2·3
	5	2·3	96·0	4·0
Individual cleared peat samples				
Depth	Sample	pH	Loss on ignition (%)	Ash (%)
0–1 ft	1	1·8	95·5	4·5
	2	2·4	86·6	13·4
	3	2·8	91·9	8·1
	4	2·5	96·7	3·3
	5	2·4	94·8	5·2
1 ft–2 ft	1	2·5	83·4	16·6
	2	2·3	94·8	5·2
	3	2·6	96·2	3·8
	4	2·6	86·7	13·3
	5	2·8	52·3	47·7
2 ft–4 ft	1	2·9	44·0	56·0
	2	2·5	68·4	31·6
	3	2·7	80·7	19·3
	4	2·9	43·3	53·7
	5	3·4	29·1	70·9

The determination of moisture content on the field samples was meaningless and was not carried out. pH was measured on a 1 : 5 peat to 1M KCl suspension and loss of ignition by igniting at 800°C. for 4 hours. It was found that ignition for 1 hour was insufficient.

The samples from each depth showed similarity of results for pH and loss on ignition values except for the cleared peat in the 2 ft–4 ft samples where more or less of the underlying clay was taken in sampling. Therefore the samples for each depth were bulked and further analyses were carried out on these bulked samples. In the samples from the virgin peat the colours of the ashes from each depth were similar and graded from grey to yellow-grey in the top to pink in the 2 ft–4 ft depth and provided an additional reason for bulking the samples in this manner. This also occurred in the ash colour of the ignited cleared peat samples.

Table 2
pH, Loss on ignition (%) and ash (%) of bulked samples of Klang peat

Virgin peat						
Depth	Loss on ignition (%)	Ash (%)	pH	N %	Org. C %	C/N Ratio
0–1 ft	95·8	4·2	2·4	1·9	33·0	17·3
1 ft–2 ft	97·0	3·0	2·4	1·3	27·0	20·8
2 ft–4 ft	95·7	4·3	2·3	0·3	22·0	24·4
Cleared peat						
Depth	Loss on ignition (%)	Ash (%)	pH	N %	Org. C %	C/N Ratio
0–1 ft	91·6	8·4	2·7	1·1	23·5	21·4
1 ft–2 ft	84·7	15·3	2·7	0·8	22·5	28·1
2 ft–4 ft	55·8	44·2	2·7	0·6	13·0	21·6

Analysis of Bulked Peat Samples

In addition to loss on ignition and pH determination nitrogen was determined by the Kjeldahl method and organic carbon by the Walkley and Black method (Piper, 1950). These results are shown in Table 2. Further determinations were made according to the methods of Jackson (1958) and included determinations of sulphur (gravimetrically) and phosphorus, manganese, iron, copper, zinc, silica colorimetrically. These results are shown in Table 3 together with the aluminium results which were determined by the difference method according

Table 4
Total Cation and Anion exchange capacities of Klang peat

Virgin peat		
Depth	Total Cation exchange capacity m.e. % of oven dried peat	Total Anion exchange capacity m.e. % of oven dried peat
0–1 ft	98	0·19
1 ft–2 ft	122	0·46
2 ft–4 ft	120	0·06
Cleared peat		
0–1 ft	76	0·77
1 ft–2 ft	125	0·32
2 ft–4 ft	72	0·63

to Piper (1950). Further results are shown in Table 3 of sodium, chloride, potassium, calcium and magnesium contents which were determined by flame photometry while in Table 4 the results for cation and anion exchange capacities are given.

TABLE 3

Principal inorganic ion analysis of Klang peat

Depth	Percentage B_2O_5 in dried peat	ash	Percentage K_2O in dried peat	ash	Percentage Na_2O in dried peat	ash	Percentage CaO in dried peat	ash	Percentage MgO in dried peat	ash	Percentage Fe_2O_3 in dried peat	ash	Percentage Al_2O_3 in dried peat	ash	Percentage SiO_2 in dried peat	ash	Percentage CuO in dried peat	ash	Percentage ZnO in dried peat	ash	Percentage SO_3 in dried peat	ash
Virgin peat																						
0–1 ft	0·15	3·8	0·002	0·05	0·018	0·42	0·010	0·25	0·020	0·46	4·62	11·10	0·06	1·53	3·42	82	0·02	0·45	0·05	0·88	0·42	8·30
1 ft–2 ft	0·09	3·1	0·001	0·05	0·018	0·57	0·009	0·27	0·016	0·12	0·57	9·30	0·06	1·87	2·10	70	0·01	0·41	0·09	2·65	0·62	20·87
2 ft–4 ft	0·04	0·8	0·001	0·07	0·015	0·33	0·006	0·15	0·020	0·46	0·12	2·40	0·06	1·47	3·21	75	0·01	0·32	0·01	2·01	1·07	21·00
Cleared peat																						
0–1 ft.	0·07	0·8	0·007	0·05	0·012	0·15	0·019	0·24	0·016	0·20	0·06	0·75	0·24	2·85	5·39	64	0·02	0·22	0·04	1·11	1·52	15·50
1 ft–2 ft	0·03	0·2	0·055	0·35	0·015	0·09	0·019	0·24	0·020	0·12	0·12	0·81	0·45	2·93	12·78	84	0·02	0·11	0·02	0·10	2·37	11·87
2 ft–4 ft	0·02	0·05	0·062	0·15	0·015	0·03	0·004	0·01	0·018	0·04	0·33	0·78	1·38	3·13	23·40	53	0·01	0·01	0·05	0·10	4·02	8·00

Peat fractions were determined according to the procedure of Konanova (1961) as

1. Humic substances insoluble in O.1N.NaOH—*humin*, *ulmin*.
2. Humic substances soluble in O.1N.NaOH and soluble in O.1N.HCl—*crenic* and *apocrenic acid*.
3. Humic substances soluble in both O.1N.NaOH and O.1N.HCl and
4. (*a*) soluble in alcohol—*Hymatomelanic acid*.
   (*b*) insoluble in alcohol—*humic* and *ulmic acids*.

These results are shown in Table 5.

Table 5

Fractions of Klang peat
Peat fractions as a percentage of the total when determined on an air dry basis

Depth	Humin and Ulmin	Humic and Ulmic acids	Hymatomelamic acid	Crenic and Apocrenic acids
		Virgin peat		
0–1 ft	32	25	9	8
1 ft–2 ft	40	25	11	11
2 ft–4 ft	32	22	15	4
		Cleared peat		
0–1 ft	30	21	14	12
1 ft–2 ft	31	15	6	10
2 ft–4 ft	21	12	3	10
When calculated on oven dried peat the percentages were :				
		Virgin peat		
0–1 ft	43	33	12	12
1 ft–2 ft	47	29	13	11
2 ft–4 ft	42	29	19	8
		Cleared peat		
0–1 ft	39	27	18	16
1 ft–2 ft	51	23	11	15
2 ft–4 ft	46	27	6	22

In further analysis the functional groups of peat and the peat fractions were determined according to the method of Konanova (1961). The total content of carboxyl and phenolic hydroxyl groups were determined by titration with barium hydroxide and carboxyl groups by reactions with calcium acetate. The results are tabulated in Table 6 for complete peat and for the peat fractions.

Discussion

It is evident that the very low pH of Klang Peat is not particularly conducive to plant growth. This coupled with the usual low level of nutrients, the presence of often toxic concentrations of sulphur leading to the formation of sulphuric acid and the lack of mechanical support for plants makes the peat very unattractive as a medium for crop growth. Nevertheless, lowland peat occurs in areas which are otherwise ideal for the growth of padi so that the shallow peat in particular is being continually cleared and used for production.

However, the results show that clearing and draining have not resulted in any great accumulation of plant nutrients and, in fact, drainage has resulted in the leaching of most of the elements. The leaching of iron was shown by experi-

TABLE 6

Functional groups of Klang peat and of the peat fractions
Results are quoted in m.e. per 100 g of oven dried peat.

Depth	Functional groups			Humin and Ulmin fractions			Humic and Ulmic acids fraction			Crenic and Apocrenic acids fraction			Hymatomelanic acid fraction		
	Carboxyl + Phenolic hydroxyl groups	Carboxyl groups	Phenolic groups	Carboxyl + Phenolic hydroxyl groups	Carboxyl groups	Phenolic groups	Carboxyl + Phenolic hydroxyl groups	Carboxyl groups	Phenolic groups	Carboxyl + Phenolic hydroxyl groups	Carboxyl groups	Phenolic groups	Carboxyl + Phenolic hydroxyl groups	Carboxyl groups	Phenolic groups
							Virgin peat								
0–1 ft	426	23	403	1840	90	1750	2020	290	1730	920	360	560	1660	270	1390
1 ft–2 ft	430	21	409	1840	90	1750	2200	330	1870	1120	260	860	1480	260	1220
2 ft–4 ft	465	22	443	1840	100	1740	2020	350	1650	1480	310	1170	1660	290	1370
							Cleared peat								
0–1 ft	460	26	434	1660	80	1580	2020	260	1760	1660	220	1440	1280	280	1000
1 ft–2 ft	375	29	346	2020	90	1930	2020	340	1680	1660	220	1440	1480	290	1190
2 ft–4 ft	360	34	326	1660	90	1570	1660	260	1400	920	290	630	1480	180	1100

ment to be very rapid. Samples of virgin peat were shaken with water (2 g. of 2·00 mm. peat in 250 mls. of water) for 1/2 hour and the iron content determined colorimetrically after standing overnight. As shown in Table 7 the iron content of the peat was reduced to 1/3 of its initial value.

Table 7

Fe_2O_3 content of virgin peat before and after leaching
% Fe_2O_3 (dry basis)

Depth	Before leaching	After leaching
0–1 ft	2·85	0·91
1 ft–2 ft	0·21	0·10
2 ft–4 ft	0·13	0·06

The agricultural utilization of lowland peat has been the subject of a number of investigations including those of Coulter (1950), Coulter *et al* (1956), and van Wijk (1951). Although special cultivation methods have been used when growing padi on peat and a number of methods advocated for reducing the high acidity such as liming together with suggestions such as the growing of leguminous plants as green manure crops it is probable that only the shallow peat can be used advantageously. The shallow peat when cleared and drained has its depth reduced so that plants and particularly tree crops are able to penetrate to the underlying clay which affords mechanical support, is usually richer in plant nutrients and is less acid.

It is possible to use peat as a fuel and this possibility has been indicated by Fitch (1953). North Borneo peat had calorific values which ranged from 8,500 to 9,200 BTU/lb. (4,700—5,100 cal/g.). These values are comparable with those of peats from Europe but it is probable that peat extracted could only be used for power production in light industries and this is unlikely to be economic in a country where hydro-power and oil are readily available.

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